

Conductivity is on the rise in New Hampshire's lakes and ponds: What is causing the increase and what can be done?

INTRODUCTION

The conductivity level in many lakes and ponds throughout the state, particularly in the more developed areas of the state and near major roadways, is increasing at a statistically significant rate. Many of the volunteer monitors participating in the Volunteer Lake Assessment Program have recently brought this to the attention of DES and have asked what is causing the increase, how it will affect the aquatic organisms, and what can be done about it.

Conductivity is the numerical expression of the ability of water to carry an electrical current. It is determined by the number of ionic particles present in the water. Natural sources, such as iron and manganese deposits in bedrock, can influence conductivity. The soft waters of New Hampshire have traditionally had low conductivity values.

Sources of elevated and increasing conductivity are typically due to human activity such as road salting, faulty septic systems, and urban/agricultural runoff. New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which may also contribute to increasing conductivity.

ROAD SALT AND WATER QUALITY

It is likely that the increase in conductivity in surface waters in New Hampshire is largely due to the application of road salt on roadways throughout the state during the winter.

The amount of snowfall in northern New England and the necessity of overland travel require the use of plows and de-icing materials to keep highways safe in the winter. Salt, or sodium chloride, is the most commonly used de-icing material in New Hampshire. In general, the purpose of salt is to: 1) reduce adherence of snow to the pavement; 2) keep the snow in a "mealy" condition and thereby permit nearly full removal by plowing; and 3) prevent the formation of ice or snow ice (hard pack).

Sodium chloride can negatively impact drinking water and aquatic life. Sodium is a drinking water concern for individuals restricted to low-sodium diets due to hypertension (high blood pressure), although a review of scientific evidence by the U.S. Environmental Protection Agency showed that the vast amount of sodium ingestion (90 percent) was from food rather than drinking water and that the linkage between sodium and hypertension was still not well documented. Chloride can affect the taste of drinking water, but is not a health concern. If levels of either sodium or chloride approach 250mg/l in drinking water, an alternative source should be found. Chloride ions were found by the U.S. Environmental Protection Agency to be toxic to certain

forms of aquatic life. Among the species tested, freshwater aquatic plants and invertebrates tend to be the most sensitive to chloride. (For a more detailed explanation regarding chloride, please refer to page 17 of the 2004 Annual Report.)

Roadside vegetation is visibly impacted from road salt. Burned grass and shrubs, as well as burned foliage on roadside trees from salt spray are common in New Hampshire.

Road Salt Management Issues

The New Hampshire Department of Transportation's (DOT) winter maintenance goal is to obtain bare and dry pavements on most roads at the earliest practical time following cessation of a storm. Many municipal highway departments have similar goals. Traffic volume, speed, and gradient are the primary factors in determining the level of winter maintenance service for particular roads. When the temperature is 20°F or greater, DOT applies approximately 250-300 pounds of salt per lane-mile and/or abrasive (sand) as needed. At temperatures below 20°F, DOT uses various combinations of salt, sand, and calcium chloride, depending on road conditions (DES Fact Sheet WMB-4, 1996).

Salt storage facilities can have a greater potential for causing water pollution than roadway application. For maximum environmental protection, salt storage facilities should be roofed and paved, with adequate drainage controls to prevent runoff water from contacting salt.

WHAT IS CAUSING THE INCREASE IN CONDUCTIVITY IN MY LAKE/POND?

We would like to encourage monitoring groups who have observed increases in conductivity results for their lake or pond and its tributaries to expand their sampling program to include conductivity surveys and chloride sampling. This additional sampling may help monitoring groups and DES pinpoint the sources that are contributing to the increase.

Lake Shoreline and Stream Conductivity Surveys

To conduct a "stream survey", members from your monitoring group should walk along the banks of each stream which has elevated conductivity levels. Typically it is best to start at the lake/pond edge and then walk along the stream up into the watershed. If possible, it is best to walk the entire length of the stream up to the headwaters (the start) of the stream (however, this may not be feasible for certain streams). We recommend that your group take conductivity samples immediately upstream and downstream of potential pollution sources (such as road crossings, homes with suspected failing septic systems, construction sites, bedrock outcroppings) according to the bracket sampling technique. Please be sure to identify all sampling stations on a map and fill out a station identification form so that the new sampling stations can be added to the VLAP database. If possible, please photograph all stations and potential pollution sources. Submit your map(s), notes, photographs, station identification forms, and samples to the VLAP Coordinator. (For a more

detailed explanation on how to conduct a stream survey and bracket sampling, please refer to the 2002 VLAP Annual Report Special Topic Article “Advanced Monitoring Techniques: Stream Surveys and Stormwater Sampling” or contact the VLAP Coordinator.)

To conduct a lake shoreline survey, your group should schedule to borrow a field conductivity meter from the DES Limnology Center (or your group may want to purchase its own field conductivity meter). It would be best to obtain the tax maps for the shoreline properties around the lake (if this is not possible, a lake outline map can be used). Drive the boat slowly with the conductivity meter probe placed approximately 6-12” in the lake (make sure the probe remains submerged in the lake and will not be cut by the engine propeller). Travel as close as possible to shore, but be careful to avoid any potential safety hazards. On the map(s), record the conductivity readings. If a particular area of the lake appears to have a higher conductivity level than most other areas of the lake, you will want to explore this area further. Take a close look at the land that surrounds this area and note and photograph any potential pollution sources. If a tributary enters the lake in this area, it would be best to conduct a conductivity survey of the stream (you can also use the field conductivity meter along the stream to pinpoint sources of elevated conductivity). Photograph potential sources of pollution and mark their location on the map. Submit your map(s), notes, and photographs to the VLAP Coordinator.

Chloride Sampling

The chloride ion (Cl⁻) is found naturally in some surface waters and groundwaters and in high concentrations in seawater. Higher-than-normal chloride concentrations in fresh water, due to sodium chloride (table salt) that is used on foods and present in body wastes, can indicate sewage pollution. The use of highway deicing salts can also introduce chlorides to surface water or groundwater. As discussed previously, in New Hampshire, the application of road salt for winter accident prevention is a large source of chloride to the environment, which is increasing over time due to the expansion of road networks and increased vehicle traffic.

Chloride ions are conservative, which means that they are not degraded in the environment and tend to remain in solution, once dissolved. Chloride ions that enter ground water can ultimately be expected to reach surface water and, therefore, influence aquatic environments and humans.

If your lake/pond is located near a major roadway, and is experiencing increasing conductivity, we may have recommended that your group collect chloride samples from the deep spot and the tributaries near the roadway. It is best to conduct chloride sampling in the spring soon after snow melt and after rain events. To collect chloride samples, simply fill one additional big white bottle. *(Please note that there will be an additional cost for chloride samples and that the satellite laboratory at Colby Sawyer College can not process chloride samples.)*

DES will compare the chloride results to the state standards that have been developed to protect freshwater aquatic life in New Hampshire (for more detailed

information regarding state standards for chloride, refer to page 18 of the 2004 Annual Report). In addition, DES will compare the deep spot chloride results to the most recent deep spot chloride results collected through the DES Lake Survey Program for your lake/pond. This comparison will allow DES to determine if there has been an increase in the in-lake chloride concentration over time. (Note: Lake Surveys are conducted for each publicly-owned lake/pond approximately once every ten to fifteen years.)

MANAGEMENT ACTIONS TO REDUCED INCREASING CONDUCTIVITY

As discussed previously, sources of elevated and increasing conductivity are typically due to human activity such as road salting, faulty septic systems, and urban/agriculture runoff. New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which contributes to increasing conductivity.

As a watershed resident, you can help prevent or minimize the potential for an increasing conductivity trend in your lake/pond by doing the following:

1. Limit soil disturbance and bedrock exposure on your property.
2. Create vegetative buffers to filter and reduce the amount of stormwater runoff from your property.
3. Replace a conventional beach with a perched beach.
4. Pump your septic system tank once every one to three years.
5. Replace/upgrade a failing leachfield immediately.
6. Discuss alternatives to road salt use near the lake and its tributaries with the Town Road Agent or DOT Agent for your region (see below for a more detailed explanation).

Alternatives to Road Salt

Salt (sodium chloride) is the most commonly used highway de-icer in New Hampshire. Its effectiveness decreases as temperatures drop. Salt is most effective at temperatures above 20° F. Below 10° F, salt cannot dissolve and cannot break the ice-pavement bond.

The second most commonly used de-icing chemical, calcium chloride, is effective in much lower temperatures than sodium chloride (as low as 0° F). Liquid calcium chloride can be used to pre-wet sodium chloride and sand, which can facilitate de-icing at lower temperatures. The disadvantages to calcium chloride are: 1) it costs more than sodium chloride; 2) it is difficult to handle and store; 3) if used alone it may contribute to slippery, black-ice conditions; and 4) the presence of chloride ions makes calcium chloride at least as corrosive to structural materials and toxic to aquatic life as sodium chloride.

Sand is sometimes considered an alternative to sodium chloride. Sand does provide additional traction in slippery conditions but it cannot melt snow and ice on the road surface. A disadvantage to sand is that great effort must be expended to clean

the sand from road surfaces at the end of winter to prevent clogging of roadside ditches and catch basins, and eventually sedimentation in water bodies.

Calcium magnesium acetate (CMA) is another alternative to sodium chloride. CMA is made from limestone and acetic acid, the principal ingredient of vinegar. CMA is less damaging to soils, less corrosive to concrete and steel, and non-toxic to aquatic organisms. It is also benign to roadside vegetation. The components of CMA are not harmful to groundwater, although CMA, like sodium chloride, has the potential to mobilize trace metals (Fe, Al, Zn, Cu) through cationic exchange reactions in soil. A drawback of CMA is its cost, approximately \$600/ton, compared to approximately \$40/ton for sodium chloride. However, a full cost analysis comparing CMA to sodium chloride is needed to determine the full cost of both alternatives. CMA use should lead to longer lasting bridges and cars and less environmental damage. Including avoided costs, CMA may be an economically viable alternative to sodium chloride, even though its initial cost is approximately 15 times greater. (Please note that these cost figures are based on the 1996 DES Fact Sheet WD-WMB-4).

DOT Reduced Salt Pilot Program

Chapter 239, Laws of 1994, authorized and required the DOT, in cooperation with the Nashua Regional Planning Commission, to implement a pilot program to minimize sodium chloride use during the winters of 1994-95 and 1995-96. Three test sections were found on low traffic volume highways in the Nashua region, public hearings were held, and warning signs were posted on the roads. During the two winters, test sections were treated with approximately one-half the amount of sodium chloride used on the control sections, which were treated using standard DOT procedures. DOT evaluated road conditions, accidents, costs, environmental benefits, and public acceptance of the pilot program. Monitoring wells were installed along test and control highway sections to measure chloride levels in groundwater (DES Fact Sheet WMB-4, 1996).

The results of the pilot program were:

1. While poorer driving conditions were noted on the test sections, safety was not significantly compromised by the reduction in sodium chloride use. This was attributed to the absence of curves, hills, and heavy traffic on test sections, as well as the highway signage and public notification of the program.
2. While substantial savings for sodium chloride were noted, other costs such as sand and labor were higher. Additional costs were estimated by DOT at \$16,774 during the two-year test period for the 8.3 lane-miles in the test sections. It was noted that additional costs could be incurred due to sand cleanup for lawns, drainage ditches, and culverts. DOT also noted that the higher costs were partially due to the short length of the test sections.
3. Public acceptance of the test was mixed. Very few complaints were from the public, but local police were less than satisfied with road conditions during storms.
4. In each test section, chloride levels in monitoring wells were substantially lower than those in corresponding control sections. Application of additional sand in

test sections created environmental concerns due to sediment deposition, but these impacts were not measured.

DOT concluded that reduced sodium chloride application for winter maintenance is beneficial within very specific parameters. The type of highway to be included in a reduced sodium chloride program needs to be carefully considered. The highway must be relatively flat, without hills and curves, and in a low speed/low volume section. Based on the results of the pilot program, DOT will consider conducting other reduced sodium chloride programs in communities which request consideration and on roads which meet the specific requirements of the program.

CONCLUSION

If the VLAP data for your lake/pond shows an increasing trend in conductivity, it is time to take action! The first step is to determine what is causing the increase. By expanding your sampling program to include lake shoreline and stream conductivity surveys and chloride sampling, your lake monitoring group and DES may be able to pinpoint the sources of increasing conductivity. After the sources have been identified, a management plan can be implemented to address (and hopefully reverse) the problem.

If the VLAP data for your lake/pond does not presently show an increasing trend in conductivity, this is not the time to be complacent! Since increasing development in many of the watersheds throughout the state is inevitable, the threat of increasing conductivity is real. There are precautions that all watershed residents can take to protect the surface waters throughout the state from becoming degraded by increasing conductivity.

References:

Road Salt and Water Quality, NHDES Fact Sheet WD-WMB-4, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.